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CARR INLET ACOUSTIC RANGE. SONAR PROPAGATION PATHS TO 1000 YARD--ETC(U)
SEP 65 F R ABBOTT, D J FRAUGHTON

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This is a working paper giving tentative information about some work in progress at NEL. If cited in the literature the information is to be identified as tentative and unpublished.

File

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NEL/Technical Memorandum 843

TECHNICAL MEMORANDUM TM-843

CARR INLET ACOUSTIC RANGE. SONAR PROPAGATION PATHS TO 1000 YARDS.

21 September 1965

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SF 001 03 16 (8132)
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No. TM-843

21 September 1965

(6) CARR INLET ACOUSTIC RANGE.

SONAR PROPAGATION PATHS TO 1000 YARDS.

by

(10) F. R. Abbott [redacted] D. J. Fraughton

~~Code 3130/3370~~

(11) 21 Sep 65

(12) 15 p.

(9) Technical memo.,

(14) NEL-TM-843

(16) FØØØ3

(17) SFØØØ316

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San Diego, California 92152

253 550 JB

THE PROBLEM

Determine the practicability of using Carr Inlet for submarine hull sonar frequency response studies. Such an appraisal requires analyses of frequency dependence of signal propagation over a prescribed path.

RESULTS

Results for one thousand yard propagation path, in the frequency band of 100 to 700 c/s.

For a unit signal transmitted, the level at the receiver will vary from 0.25 to 2 in amplitude or 18db in level. This can be tolerated for some studies by use of correction curves. The level is sensitive to bottom attenuation. A bottom reflection loss of 10db was assumed herein.

RECOMMENDATIONS

Undertake sonar tests of submarine hull resonant modes and associated scattered sound. This can be performed by adding a day to the scheduled noise trials of some submarine. It would guide future work on target classification along the lines projected from model studies described in NEL Report 1273.

ADMINISTRATIVE INFORMATION

Work was performed at NEL under AS 02 101 SF 001 03 16, task 8528 on NEL Problem E11461 (entitled: "Target Strength Study") during May and June of 1965.

INTRODUCTION

Simple geometric shaped shells act as enhanced scatterers of sonic beams at their resonant frequencies. This has not yet been successfully demonstrated using full scale submarines. The persistent resonant modes can best be established and characterized in a quiet body of water such as Carr Inlet in Puget Sound. A simple ray and phase analysis was used herein to predict any problems that will arise due to propagation anomalies between source and target.

CALCULATED SOUND INTENSITIES OVER A 3000 FOOT RANGE IN CARR INLET - BETWEEN 100 to 800 C/S.

Basic Assumptions:

Velocity of sound in sea water	4900 ft./sec
Depth of water in Carr Inlet	300 ft.
On Surface Reflections -	
Phase change	180°
Sound attenuation	0 db
On Bottom Reflections -	
Phase change	0°
Sound attenuation	10 db

This study was made to indicate the feasibility of making low frequency calibration measurements on a moored submarine at Carr Inlet in Puget Sound.

Figure 1 shows the geometry of the paths at the three depths studied, and the corresponding path lengths.

The next five pages are the tabulation of calculations made to determine the sound intensities along the different paths, the phase angle that the sound arrives with, and the resultant value of the vectorially combined signals:

Column 3 "Total Waves" is:

$$\text{Total Waves} = \frac{\text{Range Length}}{\text{Wave length @ freq. noted}}$$

Column 4 "δfrom direct path" shows the % displacement of the last wave with respect to the direct path A.

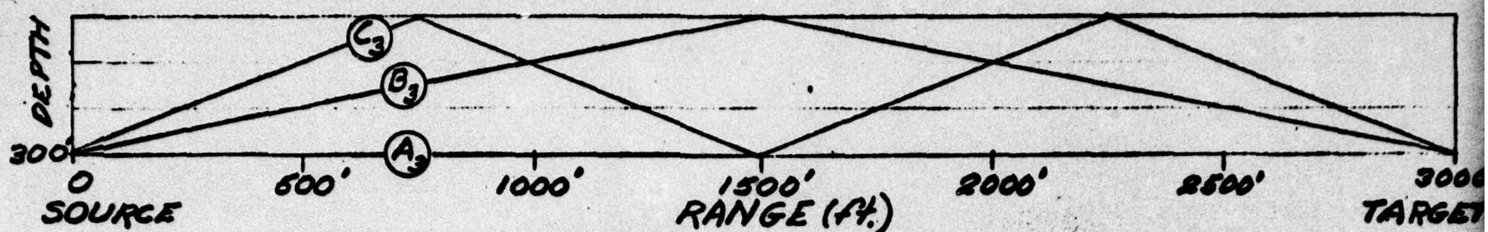
Column 5 converts column 4 to degrees.

Column 6 and 8 are from the basic assumptions.

Figure 2 illustrates the cyclic nature of the sound intensity resultants as the frequency increases from 100 to 200 c/s at 300 feet depth. A typical vector diagram is shown to illustrate how the resultants are determined graphically. Figure 3 shows amplitude in rectangular form.

Figures 4 and 5 show the phase change of each path relative to the direct path, plotted vs. frequency. From these plots one can readily see the number of phase reversals each vector goes through and determine maximum and minimum intensities quite readily, as indicated on Figure 3.

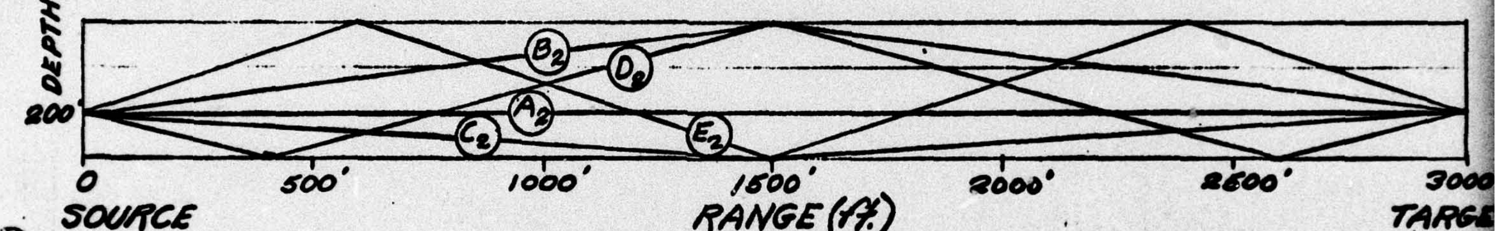
SOUND PATHS STUDIED



300 FT. DEPTH

PATH LENGTHS:

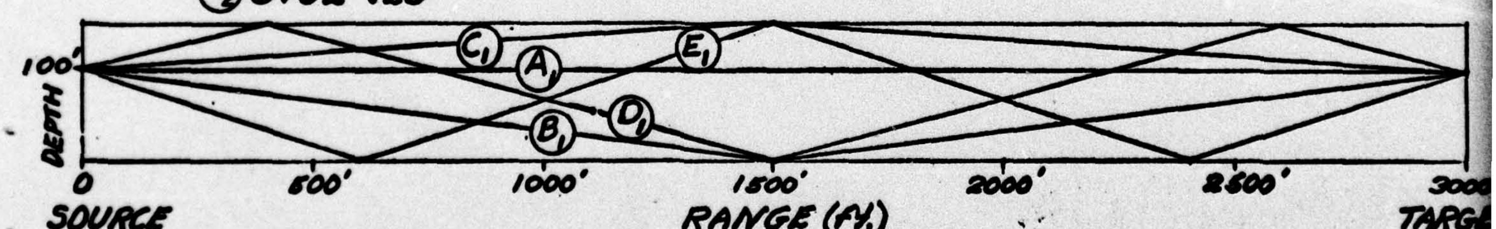
A3 3000.00 FEET
B3 3059.4 "
C3 3231.0 "



200 FT. DEPTH

PATH LENGTHS:

A2 3000.00 FEET
B2 3027.06 "
C2 3006.66 "
D2 3104.86 "
E2 3162.25 "



100 FT. DEPTH

PATH LENGTHS:

A1 3000.00 FEET
B1 3027.06 "
C1 3006.66 "
D1 3104.86 "
E1 3162.25 "

FIG. 1

63.68	.0
64.94	.26
68.58	.90
64.28	.0
65.56	.28
69.24	.96
64.90	.0
66.18	.28
69.90	.0
65.51	.0
66.81	.30
70.55	.04
66.12	.0
67.43	.31
71.21	.09

300 FT. DEPTH

CYCLES/SEC.	PATH	TOTAL WAVES	δ FROM DIRECT PATH	$\delta°$	PHASE SHIFT	$\Sigma\delta°$	Ampl.	Resultant
	A_3	85.71	.0	0°	0°	0°	1.	
140	B_3	87.41	.70	252°	180°	72°	1.	1.32
	C_3	92.31	.60	216°	360°	216°	.3	
	A_3	91.84	.0	0°	0°	0°	1.	
150	B_3	93.65	.81	292°	180°	112°	1.	1.39
	C_3	98.91	.07	25°	360°	25°	.3	
	A_3	97.96	.0	0°	0°	0°	1.	
160	B_3	99.90	.94	338°	180°	158°	1.	.38
	C_3	105.50	.54	194°	360°	194°	.3	
	A_3	104.08	.0	0°	0°	0°	1.	
170	B_3	106.14	.04	14°	180°	194°	1.	.39
	C_3	112.10	.02	7°	360°	7°	.3	
	A_3	110.20	.0	0°	0°	0°	1.	
180	B_3	112.39	.19	68°	180°	248°	1.	.96
	C_3	118.69	.49	176°	360°	176°	.3	
	A_3	116.33	.0	0°	0°	0°	1.	
190	B_3	118.63	.30	108°	180°	288°	1.	1.90
	C_3	125.28	.95	342°	360°	342°	.3	
	A_3	122.44	.0	0°	0°	0°	1.	
200	B_3	124.88	.44	158°	180°	338°	1.	1.68
	C_3	131.88	.44	158°	360°	158°	.3	
	A_3	183.71	.0	0°	0°	0°	1.	
300	B_3	187.35	.64	230°	180°	50°	1.	2.05
	C_3	197.86	.15	54°	360°	54°	.3	
	A_3	244.90	.0	0°	0°	0°	1.	
400	B_3	249.75	.85	306°	180°	126°	1.	.82
	C_3	263.75	.85	306°	360°	306°	.3	
	A_3	306.12	.0	0°	0°	0°	1.	
500	B_3	312.18	.06	22°	180°	202°	1.	.43
	C_3	329.69	.57	205°	360°	205°	.3	
	A_3	367.20	.0	0°	0	0°	1.	
600	B_3	374.47	.27	97°	180°	277°	1.	1.14
	C_3	395.47	.27	97°	360°	97°	.3	
	A_3	428.57	.0	0°	0	0°	1.	
700	B_3	437.06	.49	176°	180°	356°	1.	2.3
	C_3	461.57	.0	0°	360°	0°	.3	
	A_3	429.80	.0	0°	0°	0°	1.	
702	B_3	438.31	.51	184°	180°	4°	1.	2.27
	C_3	462.89	.09	32°	360°	32°	.3	

FIGURE 6

300 FT. DEPTH

CYCLES/SEC.	PATH	TOTAL WAVES	δ FROM DIRECT PATH	δ°	PHASE CHG.	$\Sigma\delta'$	Ampl.	Resultant
704	A_3	431.03	.0	0°	0°	0	1.	2.15
	B_3	439.57	.54	194°	180°	14°	1.	
	C_3	464.22	.19	68°	360°	68°	.3	
706	A_3	432.28	.0	0°		0	1.	2.00
	B_3	440.84	.56	202°		22°	1.	
	C_3	465.56	.28	101°		101°	.3	
708	A_3	433.63	.0	0°		0	1.	1.80
	B_3	442.11	.58	209°		29°	1.	
	C_3	466.91	.38	137°		137°	.3	
710	A_3	434.78	.0	0°		0	1.	1.62
	B_3	443.39	.61	220°		40°	1.	
	C_3	468.26	.48	173		173°	.3	
720	A_3	441.18	.0	0		0	1.	1.72
	B_3	449.91	.73	263°		83°	1.	
	C_3	475.15	.97	349°		349°	.3	
730	A_3	447.09	.0	0°		0	1.	.90
	B_3	455.96	.86	310°		130°	1.	
	C_3	481.52	.43	155°		155°	.3	
740	A_3	453.17	.0	0°		0	1.	.25
	B_3	462.15	.98	353°		173°	1.	
	C_3	488.07	.90	324°		324°	.3	
750	A_3	459.42	.0	0°		0	1.	.32
	B_3	468.51	.09	32°		212°	1.	
	C_3	494.79	.37	133°		133°	.3	
760	A_3	465.12	.0	0°		0	1.	1.52
	B_3	474.33	.21	76°		256°	1.	
	C_3	500.93	.81	292°		292°	.3	
770	A_3	471.70	.0	0°		0	1.	1.50
	B_3	481.04	.34	122°		302°	1.	
	C_3	508.02	.32	115°		115°	.3	
780	A_3	477.71	.0	0°		0°	1.	2.10
	B_3	487.17	.46	166°		346°	1.	
	C_3	514.49	.78	281°		281°	.3	
790	A_3	483.87	.0	0		0°	1.	2.01
	B_3	493.45	.58	209°		29°	1.	
	C_3	521.13	.26	94°		94°	.3	
800	A_3	489.80	.0	0	0°	0°	1.	1.45
	B_3	499.49	.69	248°	180°	68°	1.	
	C_3	527.51	.71	256°	360°	256°	.3	

FIGURE 1c

200 FT. DEPTH

CYCLES/SEC	PATH	TOTAL WAVES	δ FROM DIRECT PATH	δ°	PHASE CHG.	Σ δ°	Ampl.	Resultant
100	A_2	61.22	.0	0°	0°	0°	1.	
	B_2	61.78	.56	202°	180°	22°	1.	
	C_2	61.36	.14	50°	360°	50°	.3	
	D_2	63.36	2.14	50°	180°	230°	.1	
	E_2	64.54	3.32	115°	360°	115°	.3	
200	A_2	122.44	.0	0		0°	1.	
	B_2	123.55	1.11	40°		220°	1.	
	C_2	122.72	.28	101°		101°	.3	
	D_2	126.73	2.29	104°		284°	.1	
	E_2	129.07	6.63	226°		226°	.3	
300	A_2	183.71	.0	0		0°	1.	
	B_2	185.33	1.62	223°		73°	1.	
	C_2	184.08	.37	133°		133°	.3	
	D_2	190.09	6.38	137°		317°	.1	
	E_2	193.61	19.90	324°		324°	.3	
400	A_2	244.90	.0	0		0°	1.	
	B_2	247.11	2.21	76°		256°	1.	
	C_2	245.44	.54	194°		194°	.3	
	D_2	253.46	8.56	202°		22°	.1	
	E_2	258.14	13.24	86°		86°	.3	
500	A_2	306.12	.0	0°		0°	1.	
	B_2	308.88	2.76	274°		94°	1.	
	C_2	306.80	.68	245°		245°	.3	
	D_2	316.82	10.70	252°		72°	.1	
	E_2	322.68	16.56	202°		202°	.3	
600	A_2	367.35	.0	0°		0°	1.	
	B_2	370.66	3.31	166°		346°	1.	
	C_2	368.16	.81	346°		346°	.3	
	D_2	380.18	12.83	299°		119°	.1	
	E_2	387.21	19.86	310°		310°	.3	
700	A_2	428.57	.0	0°	0°	0°	1.	
	B_2	432.44	3.87	313°	180°	133°	1.	
	C_2	429.52	.95	342°	360°	342°	.3	
	D_2	443.55	14.98	353°	180°	173°	.1	
	E_2	451.75	23.18	65°	360°	65°	.3	

FIGURE 1d

100 FT. DEPTH

CYCLES/SEC.	PATH	TOTAL WAVES	δ FROM DIRECT PATH	δ°	PHASE CHG.	Σδ°	Ampl.	Resultant
	A_1	61.22	.0	0°	0°	0°	1.	
	B_1	61.78	.56	202°	360°	202°	.3	
100	C_1	61.36	.14	50°	180°	230°	1.	
	D_1	63.36	2.14	50°	360°	50°	.3	
	E_1	64.54	3.32	115°	180°	290°	.1	
	A_1	122.44	.0	0°		0°	1.	
	B_1	123.55	1.11	40°		40°	.3	
200	C_1	122.72	.28	101°		281°	1.	
	D_1	126.73	2.29	104°		104°	.3	
	E_1	129.07	6.63	226°		46°	.1	
	A_1	183.71	.0	0		0°	1.	
	B_1	185.33	1.62	223°		223°	.3	
300	C_1	184.08	.37	133°		313°	1.	
	D_1	190.09	6.38	137°		137°	.3	
	E_1	193.61	9.90	324°		144°	.1	
	A_1	244.90	.0	0		0°	1.	
	B_1	247.11	2.21	76°		76°	.3	
400	C_1	245.44	.54	194°		14°	1.	
	D_1	253.46	8.56	202°		202°	.3	
	E_1	258.14	13.24	86°		266°	.1	
	A_1	306.12	.0	0°		0°	1.	
	B_1	308.88	2.76	274°		274°	.3	
500	C_1	306.80	.68	245°		65°	1.	
	D_1	316.82	10.70	252°		252°	.3	
	E_1	322.68	16.56	202°		22°	.1	
	A_1	367.35	.0	0°		0°	1.	
	B_1	370.66	3.31	112°		112°	.3	
600	C_1	368.16	.81	292°		112°	1.	
	D_1	380.18	12.83	299°		299°	.3	
	E_1	387.21	19.86	310°		130°	.1	
	A_1	428.57	.0	0°	0°	0°	1.	
	B_1	432.44	3.87	313°	360°	313°	.3	
700	C_1	429.52	.95	342°	180°	162°	1.	
	D_1	443.55	14.98	353°	360°	353°	.3	
	E_1	451.75	23.18	65°	180°	245°	.1	

FIGURE 1e

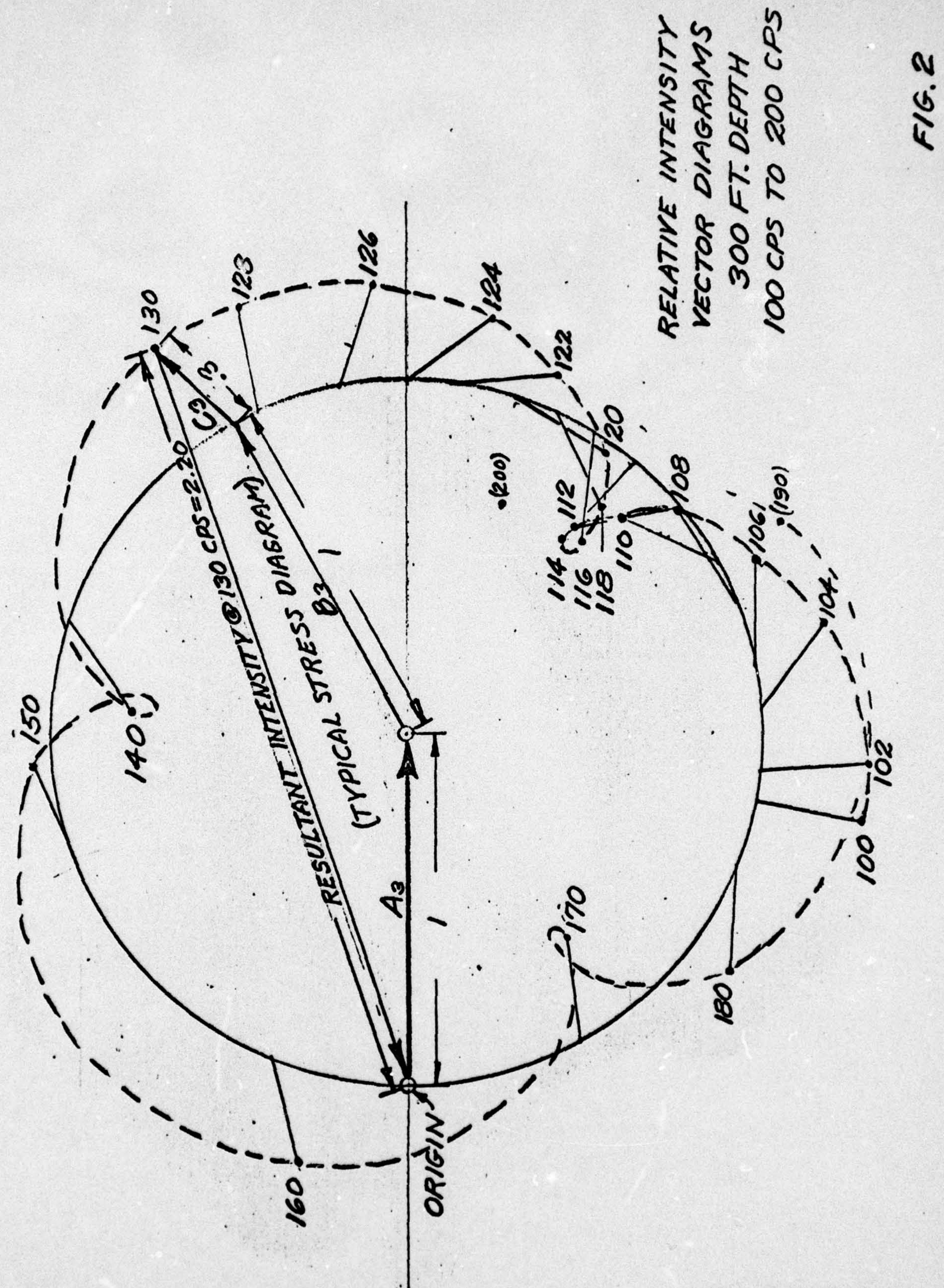
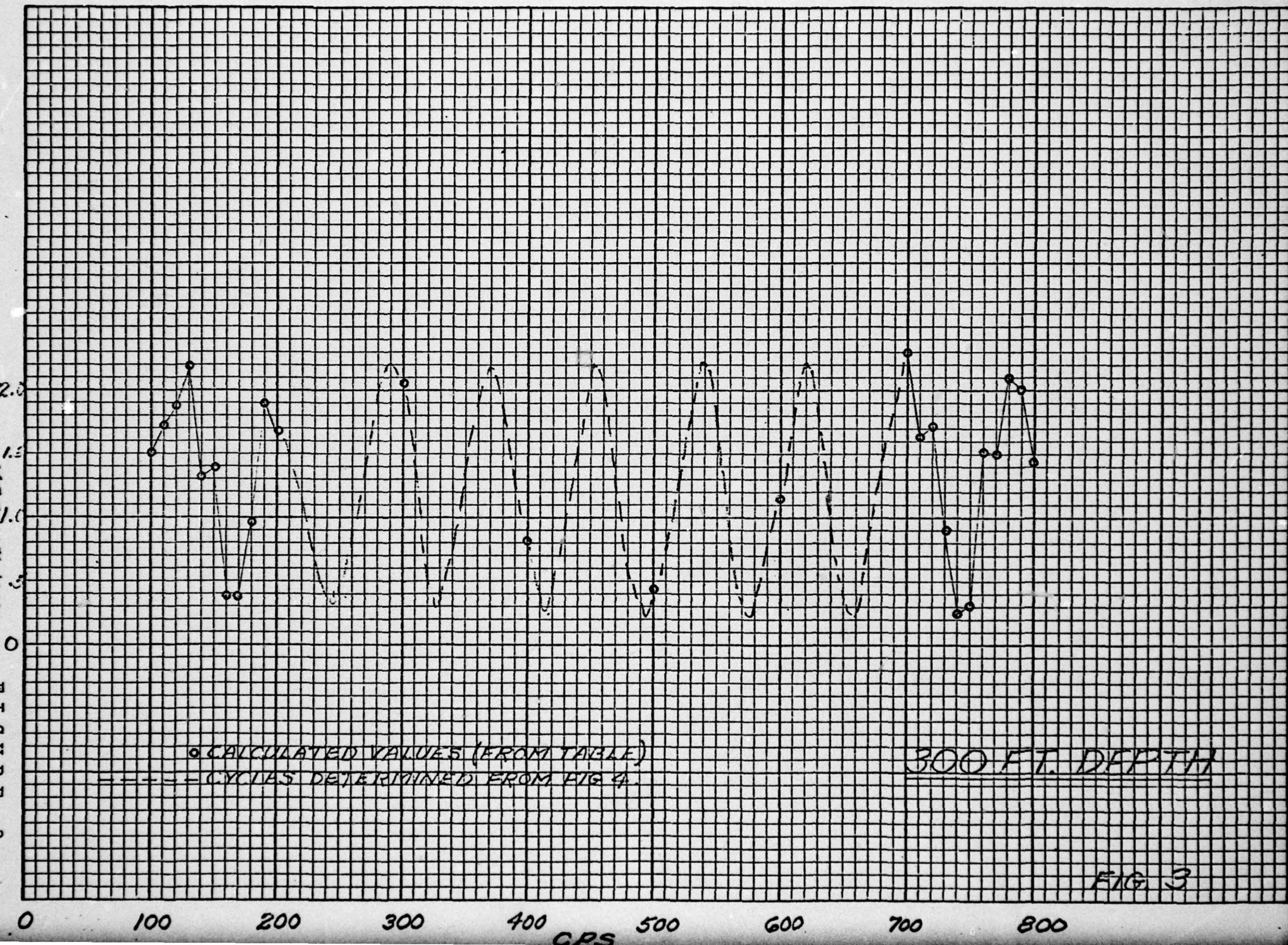

RELATIVE INTENSITY
VECTOR DIAGRAMS
300 FT. DEPTH
100 CPS TO 200 CPS
FIG. 2
RESULTANT INTENSITY @ 130 CPS = 2.20
(TYPICAL STRESS DIAGRAM)
ORIGIN
A_3
B_3
C_3
100
102
104
106
108
110
112
114
116
118
120
122
123
124
126
130
140
150
160
170
180
(190)
(200)

FIGURE 2.



AMPLITUDE
2.0
1.5
1.0
.5
0
0
100
200
300
400
500
600
700
800
CPS
o CALCULATED VALUES (FROM TABLE)
----- CYCLES DETERMINED FROM FIG 4.
300 FT. DEPTH
FIG 3

FIGURE 3.

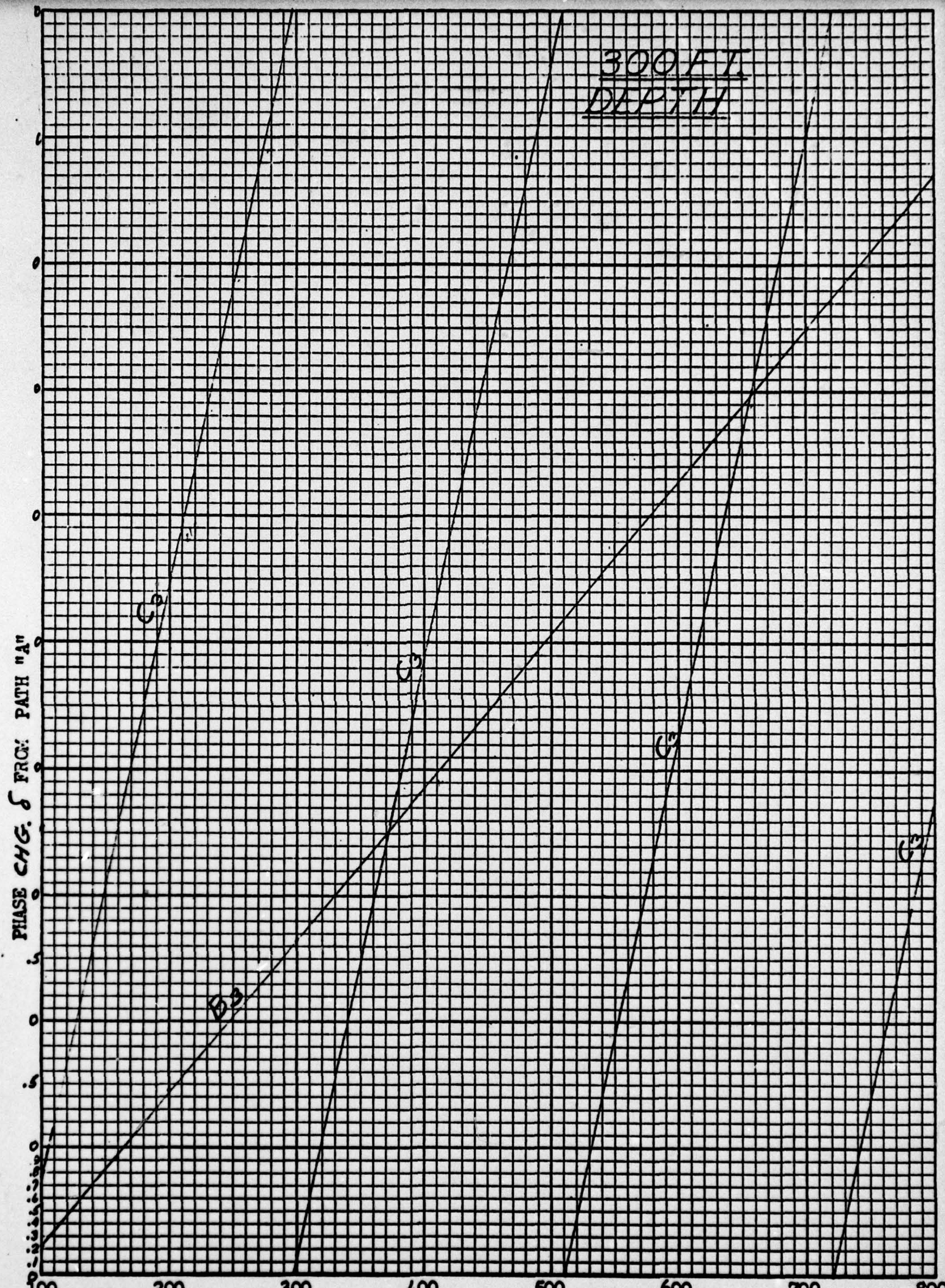
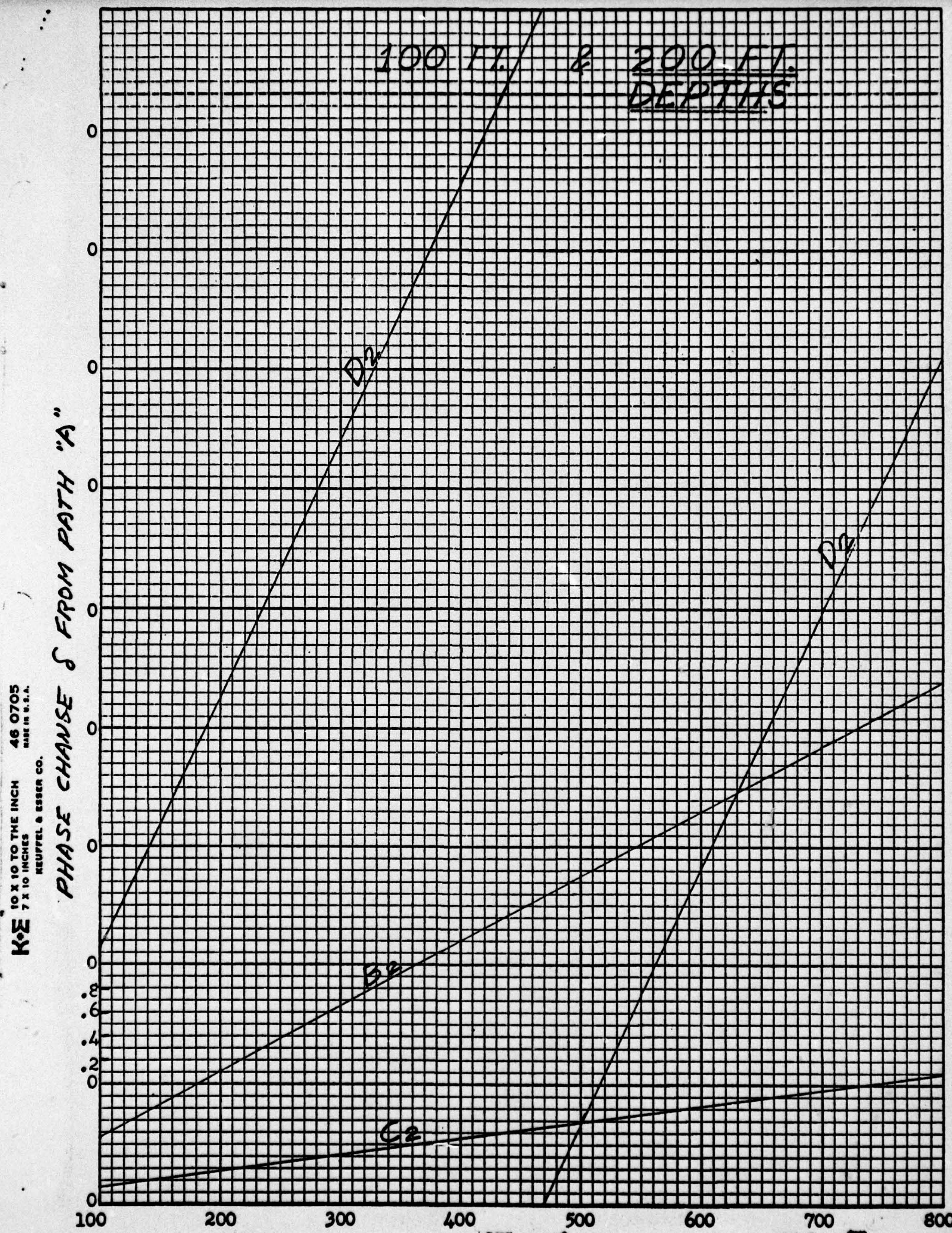

300 FT.
DEPTH
PHASE CHG. δ FROM PATH "A"
C3
C3
C3
C3
D3
100
200
300
400
500
600
700
800
CPS H

FIG. 4.



100 FT. & 200 FT.
DEPTHS
PHASE CHANGE δ FROM PATH "A"
D2
D2
B2
C2
0
0
0
0
0
0
0
0
.8
.6
.4
.2
0
0
100
200
300
400
500
600
700
800
CPS
K+E 10 X 10 TO THE INCH 7 X 10 INCHES 46 0705 KEUFFEL & ESSER CO. MADE IN U.S.A.

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FIG. 5